Study of M31 Star Clusters using the PHAT Survey

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PHAT Data

- PHAT (Panchromatic Hubble Andromeda Treasury) survey [1]: 2753 star clusters observed with 6 filters: 2 near-UV (WFC3/UVIS), 2 optical (ACS/WFC), 2 near-IR (WFC3/IR).

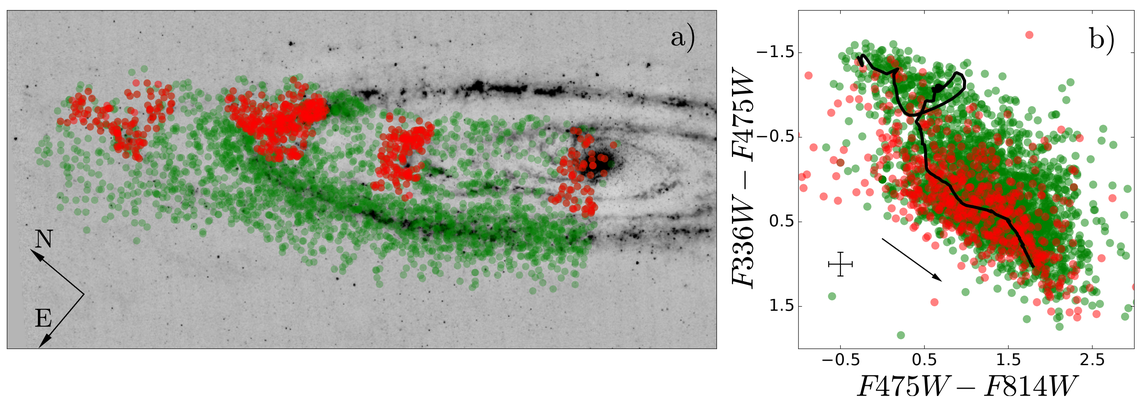

Fig. 1. Panel a): the star cluster sample of **PHAT 2012** [2], and the complete cluster catalog of **PHAT 2015** [3]. Panel b): colour-colour diagram of these data, with extinction direction ($A_V = 1$), and error bars of 0.1 mag in each filter.

Method of derivation of star cluster parameters

- We need a grid of star cluster models with star masses stochastically generated following the Initial Mass Function.
- We need a fast method of derivation of age, mass, extinction, and metallicity parameters of star clusters using integrated photometry.

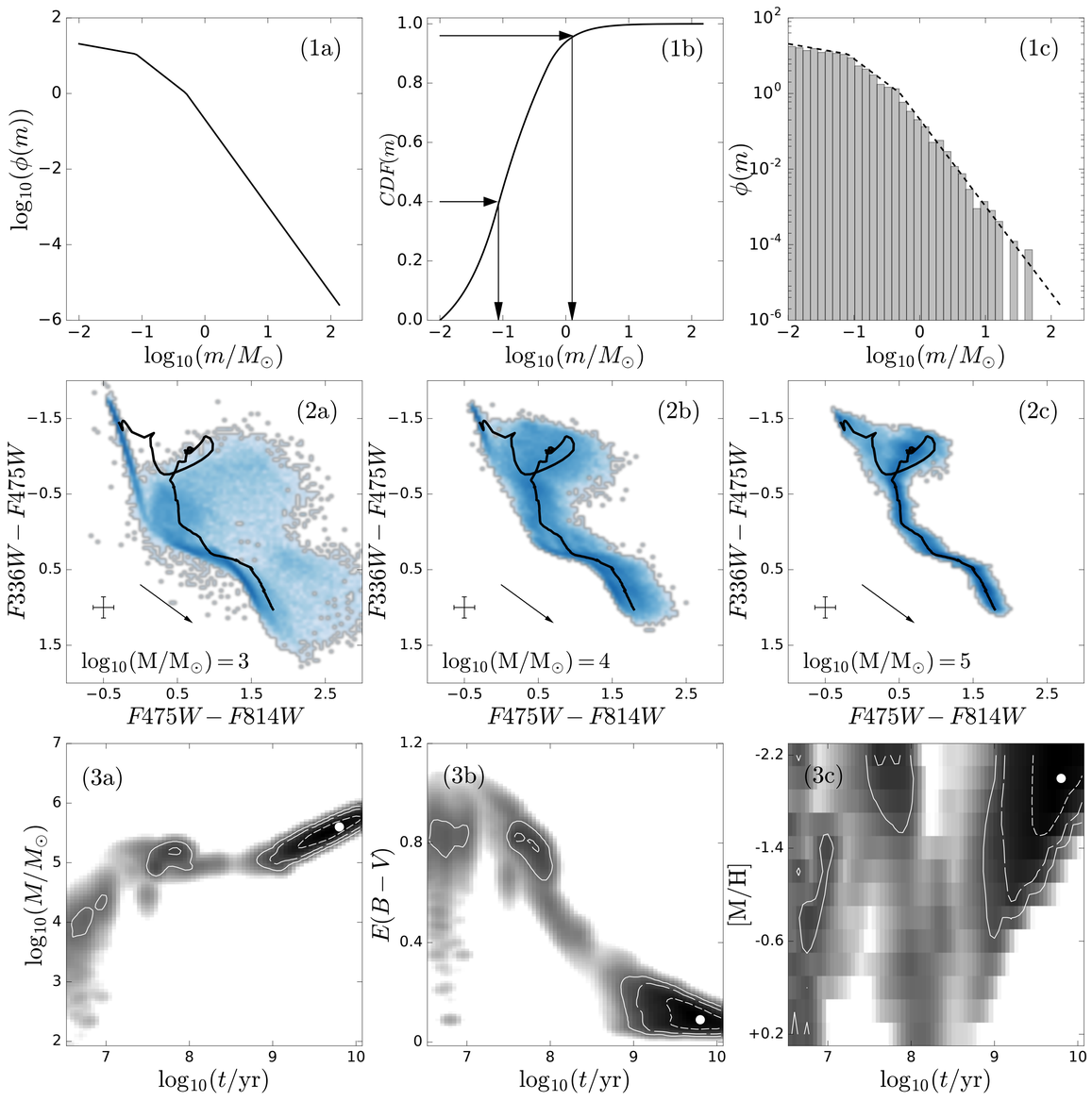

Fig. 2. Scheme of the procedure used to derive the star cluster parameters. The row of panels (1) presents the way to generate star cluster models, following [4], by stochastically populating the stellar Initial Mass Function (IMF, or $\phi(m)$), shown in panel 1a). The cumulative distribution function (CDF) of the IMF is populated uniformly between 0 and 1 and these random numbers are transformed into stellar mass by inverting the relation (panel b, see the arrows for example). The procedure is continued until the total mass of the cluster is reached, giving the cluster mass function (panel 1c). Using this method it is possible to generate a grid of models for all parameters (row 2, for 3 fixed masses). Each node of this grid contains 1000 models to account for stochasticity. Using this model grid, the parameters of observed clusters can be derived using a maximum of likelihood method (row 3). by deriving the likelihood of each node and selecting the parameters of the node with maximum likelihood (white dot). This procedure is detailed in [5–8].

Results

- The age, mass, and extinction of 1268 clusters have been derived. For young cluster (< 1 Gyr), the metallicity is fixed to solar, while left free for old massive clusters.
- Parameters derived here using photometry are comparable with those derived by spectroscopy [9,10] for both young and old clusters.

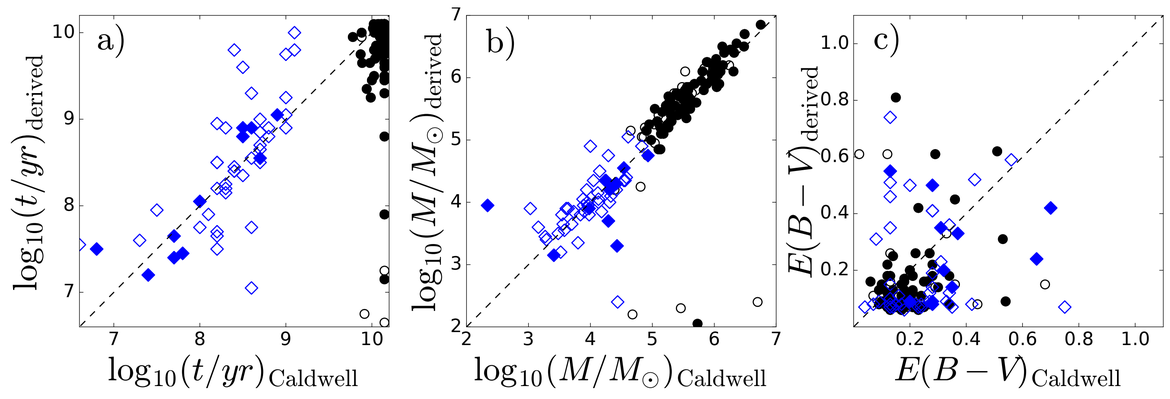

Fig. 3. Results of this work vs those of the [9,10] for **young** and **old** clusters, shown for the age (panel a), mass (b), and extinction (c). Clusters marked by filled symbols have better photometric accuracy than those marked by open symbols.

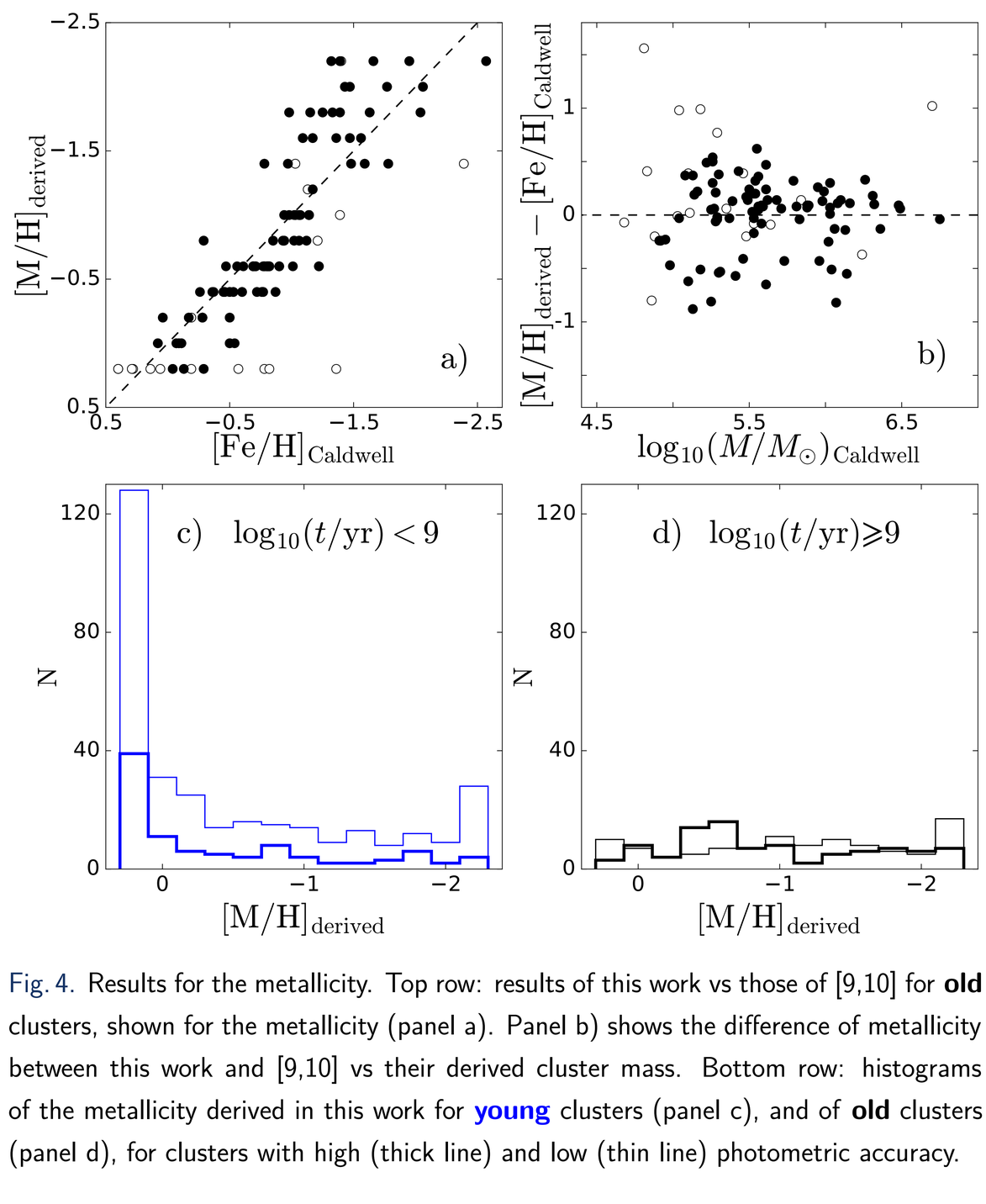

Fig. 4. Results for the metallicity. Top row: results of this work vs those of [9,10] for **old** clusters, shown for the metallicity (panel a). Panel b) shows the difference of metallicity between this work and [9,10] vs their derived cluster mass. Bottom row: histograms of the metallicity derived in this work for **young** clusters (panel c), and of **old** clusters (panel d), for clusters with high (thick line) and low (thin line) photometric accuracy.

References

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